Universal Temperature Controller for $70

Written By: Abe

TOOLS:

- Phillips and Flathead Screwdriver (1)
- Scissors (1)
- Wire stripper/crimper (1)

PARTS:

- Pt-100 RTD probe (1)
- PID temperature controller JLD 612 (1)
- 25A solid state relay (1)
- SSR heat sink (1)
- Spade/ring/butt terminals (1)
- 2 foot air conditioner extension cord (1)
- 2 foot 12-gauge wire (1)
- 1 foot two-conductor 18-gauge wire (1)
- Electrical Tape (1)
- Duct tape (1)

SUMMARY

A while ago we built a $50 dollar sous vide machine to start messing around with sous vide cooking. We loved it, and it has been precise and stable over a long period of time.

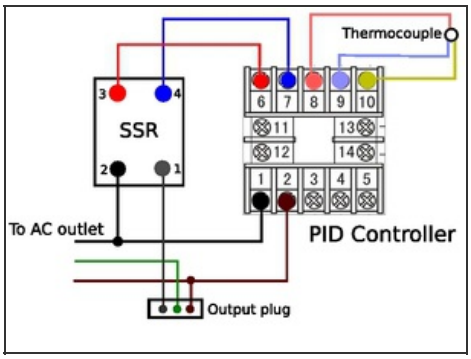
However, we thought it'd be awesome to create a brain that could control anything based on the thermocouple output. Something that would work with a rice cooker, bucket heater, or even a smoker. We could've gone out and bought a $160 Sous Vide Magic, but we built our own controller for $70! And now we'll show you how to DIY.

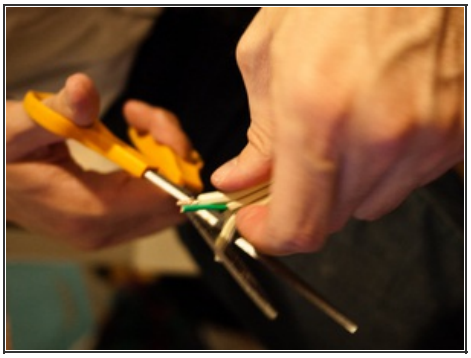
Again we've avoided soldering anything, which simplifies the construction considerably.

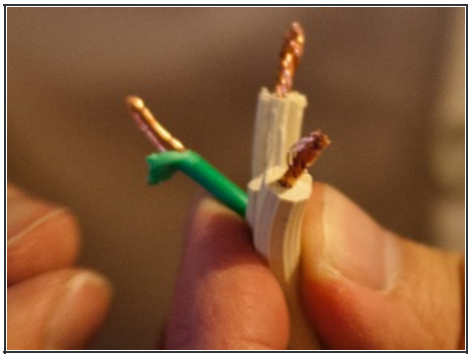
You can check out some recipes and more DIY sous vide advice at our blog. The details in this guide are posted there as well.

Warning: do not embark on this if you are not comfortable with electronics, including high voltages. Some connections carry AC power direct from the wall outlet which can lead to personal injury or death.

Step 1 — Main power cord and output socket

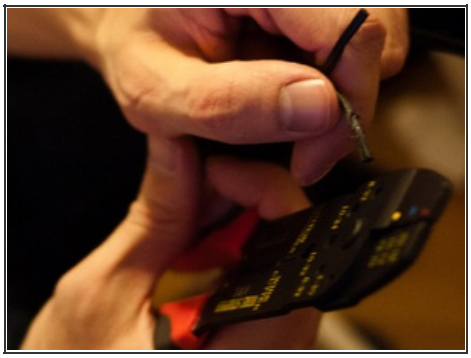


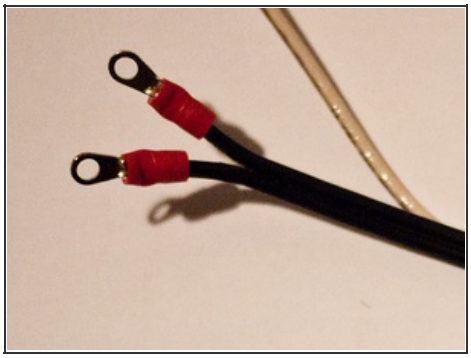




- Use scissors to cut six inches of extension cord from the female end (output socket). You should be left with 18 inches of wire on the male end (the main power cord).
- For each end, carefully cut along the cord to separate the three wires: the two power lines and the ground.
- Now, strip the three wires on both ends by carefully squeezing the scissors at different angles on the cord until the insulator is detached. Less than ½ inch should be bare.

Step 2 — PID power cord



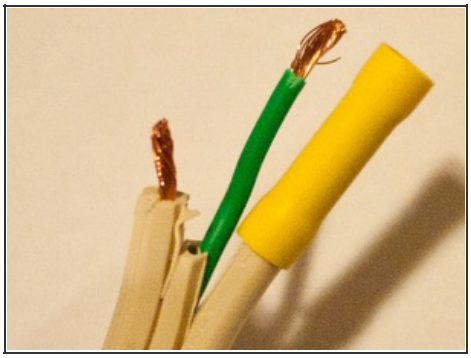
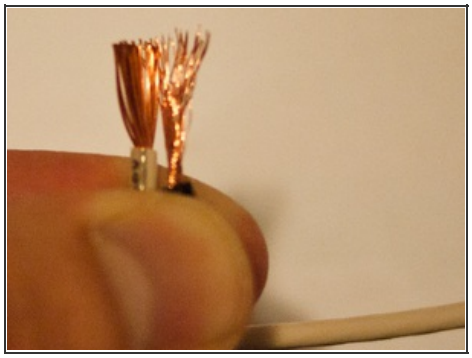
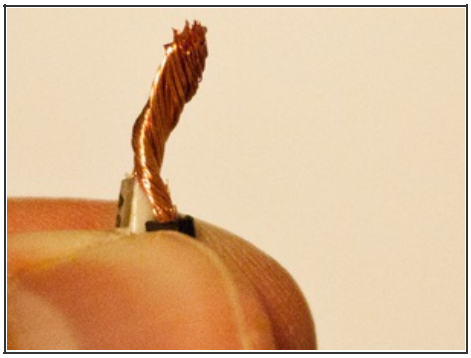


- In order to supply power to the PID controller we will cut our double-stranded wire in half (the other half will be used for the relay control cord).
- Now split the wire in half by a half inch.
- Strip the ends to expose the copper wire.
- Choose ring terminals that will fit on the screws on the back of the PID controller, then use the crimper to attach the ring terminals to the ends of the wire.
- Separate and strip the wires on the other end of the cord just as before -- we later crimp this end and attach it to the main power cord.

Step 3 — Power relay wires

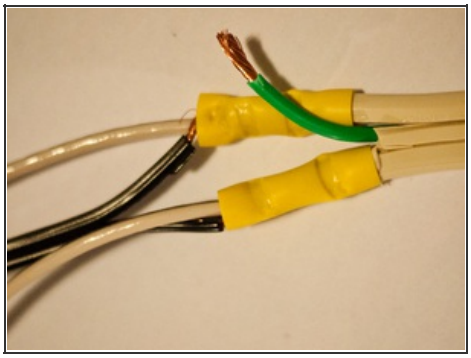
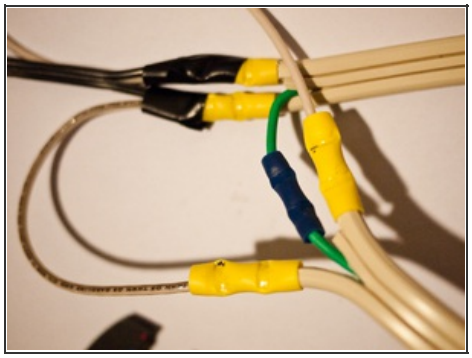
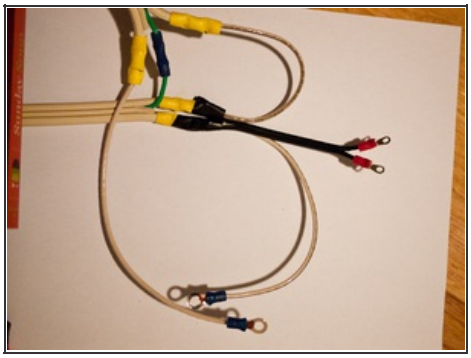
- Cut the 12-gauge wire into three wires of equal length.
- Strip both ends of each wire so ½ inch of copper is exposed.

Step 4 — Splicing PID power cord and relay wires onto main power cord

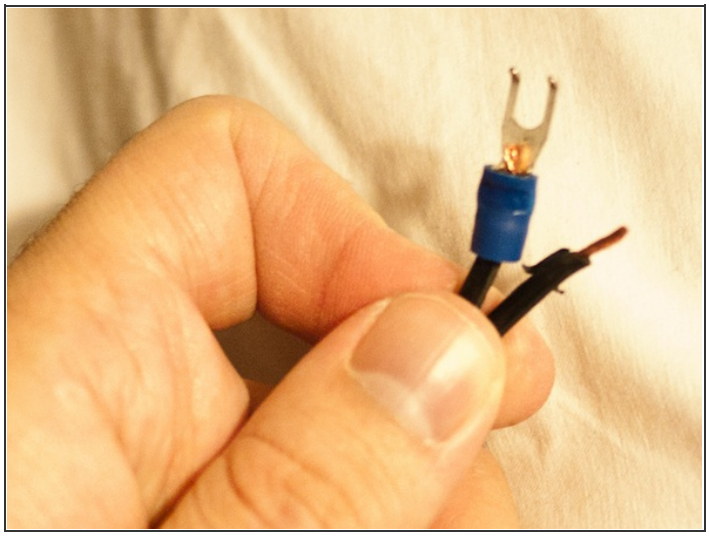
- Now we will attach two power relay wires and the PID power cord to the main power cord (the male end). Using the crimping tool, attach one end of a butt connector to a conductor of the main power cord (not the ground).
- Tug at the connector to make sure it will not come loose.
- Combine one power relay wire and one conductor of the PID power cord by flattening the copper strands with your fingers and twisting them into each other. Then put the combined bundle in the other end of the butt connector, and crimp tightly.
- Again, make sure that the connection will not come loose by tugging on the wires.
- Combine the other wire of the main power cord with the other conductor of the PID power cord, and another power relay wire through the method used above. If any wire comes loose, you may need to cut off the butt connector from the main power cord, strip the wire again and attach another connector.

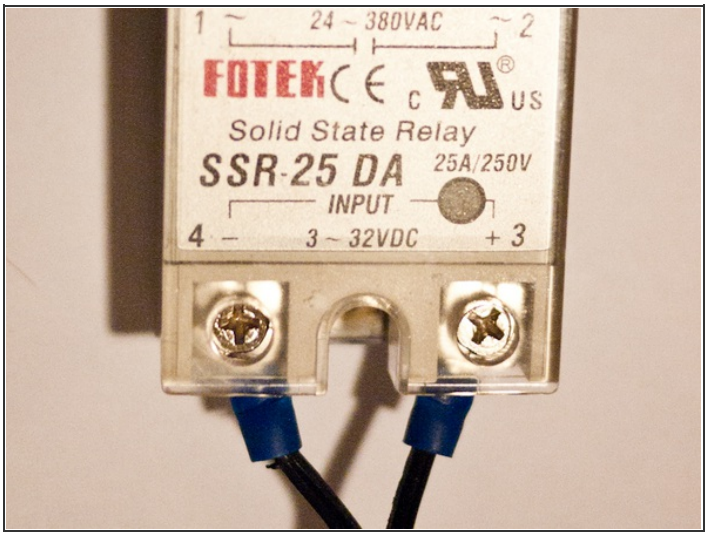
Step 5 — Connecting output socket

- Now connect the ground from the main power cord to the ground on the output socket using a butt connector.
- Attach the third power relay wire to one of the two power wires of the output socket using a butt connector.
- Then connect the remaining power wire of the output socket to the corresponding relay wire spliced off of the main power cord (to determine which is the corresponding wire, you can plug the main power cord into the output socket).
- At this point, the only remaining free ends should be the two ring electrodes on the PID power cord and two power relay wires (one on the main power cord and one on the output socket). Choose two ring terminals that will fit on the solid-state relay contacts. Then connect those ring terminals to the free ends of the power relay wires.
- Finally, pull on all your connections. If anything comes free, reconnect with another terminal, and try to squeeze harder when crimping. **Safety is more important than saving time.**

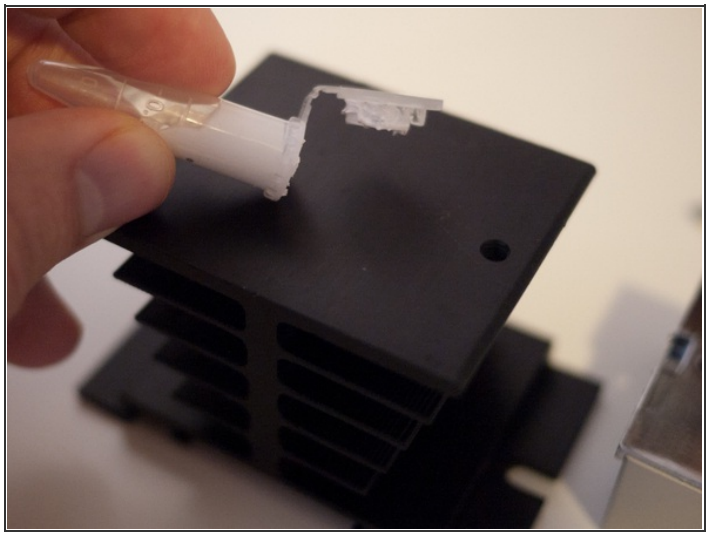
Step 6 — Relay control cord





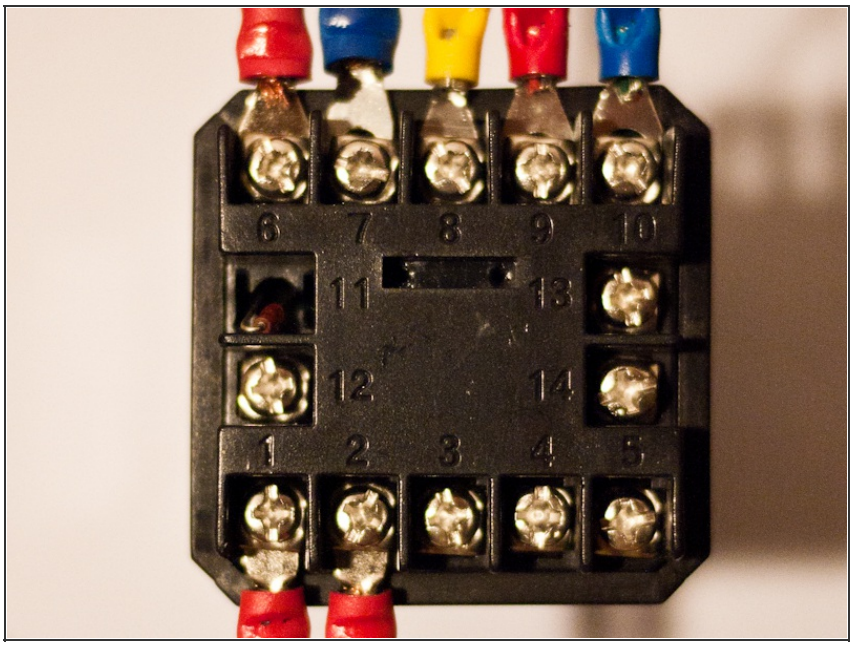
- We are almost done stripping and crimping, but we first need to make a wire to allow the PID controller to activate the relay.
- Take the remaining length of two-conductor cord, pull apart the wires at the ends, and strip them so that ¼ to ½ inch of copper is bare.
- Choose spade electrodes that fit on the connectors at the back of the PID controller and attach four of those spade electrodes to the four wire ends.

Step 7



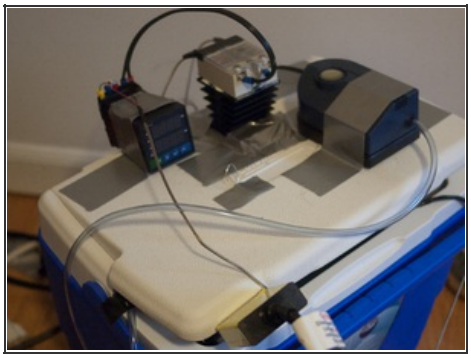
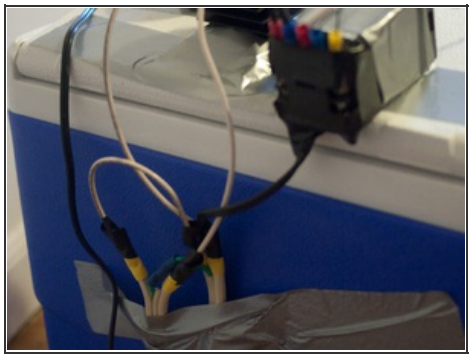
- From here on everything is easy-peasy, screwdriver-only work. Connect one end of the relay control cord to the SSR terminals 3 and 4 by screwing down the spade connectors.
- Connect the two ring terminals attached to power relay wires to SSR terminals 1 and 2 by removing the screws on the terminals, inserting the ring terminals and tightening the screws again.
- Finally, we must connect the SSR to the heat sink. The SSR is rated to 25A only if connected to a heat sink -- otherwise the rating drops to around 7A and decreases further at higher temperatures. Put thermal paste on the heat sink with a flathead screwdriver, and screw the SSR down.

Step 8



- Now connect the two ring terminals on the PID power cord to PID controller connectors 1 and 2. Again, to do this, unscrew the connector, insert the ring terminal, and put the screw back in.
- Attach the free end of the SSR control cord to PID terminals 6 and 7. Loosen the screws, insert the spade terminal, and tighten the screw again. The wire from SSR terminal 3 should go to PID terminal 6, and the wire from SSR terminal 4 to PID terminal 7.
- Finally, attach the PT100 wires to PID terminals 8, 9, and 10. If the PT100 has three wires, connect the red, blue, and yellow to terminals 8, 9, and 10 respectively. If your PT100 has only two wires, connect the red and blue to 8 and 9, and then connect 9 and 10 together with a short wire.
- One thing we noticed is that the PT100 probe gives some wonky results if the back end gets even a little wet, we wrapped it up in duct tape and electrical tape to avert this. Perhaps a better idea is to put the entire probe inside a finger of a latex glove, as we did in the DIY cheese vat.

Step 9


- Plug whatever heating element you are using (immersion heater, crock pot, etc.) into the output socket, and put the PT100 probe in the water bath (the environment being heated).
- Plug in the main power cord, and voilà! The PID controller will start to adjust the heat to reach the Set Value (SV) temperature. Adjust the SV by using the up and down arrows on the PID controller.
- Adjust your PID settings to speed up convergence to the set temperature.
- We use our universal controller to sous vide with a cooler! The setup is very simple. We tied the end of aquarium air tubing in a knot, and threaded it through the bottom holes in a bucket heater. Then, we taped an air pump to the top of the cooler, and plugged it into the surge protector. We placed the bucket heater inside a cooler, and plugged it into the controller. The controller's thermocouple is left to dangle in the water. The controller is plugged into the surge protector.
- Find recipes and more DIY sous vide advice at http://qandabe.com !

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